SUPPLEMENTARY NOTES ON AN ANT.

BY ADELE M. FIELDE.

In a preceding paper,[1] I described experiments showing that when pupæ and the ant-workers hatching therefrom are maintained in segregation, such ants refuse to affiliate with workers of their colony who are forty days or more older than themselves; and that ant-workers thus reared in segregation will not accept a queen much older than their mother. I believe it to be proven that the cause of the hostility of one colony to those of another colony of the same species and variety[2] is a difference of contact-odor coincident with difference of age in the individuals composing the colony. The queen-mother alone determining the inherent primitive odor of each of her offspring.

I recently undertook the herein recorded experiments with a view to ascertaining whether any of the rays of light to which the ants are exposed in seeking food so affects their metabolism as to produce that difference of odor which is the cause of hostility between colonies of different age.

On August 21, 1902, I put five queens and 200 workers, all of one colony and without young, into each of five new Fielde nests.[3] All

[1] "Notes on an Ant," *Proceedings of the Academy of Natural Sciences of Philadelphia*, December, 1902.

[2] The ants used for the experiments described in that paper and in the present writing were *Stenamma fulvum piceum*.

[3] "Portable Ant Nests," *Biological Bulletin*, Vol. 2, No. 2, 1900. An improvement suggested by Dr. W. M. Wheeler in the making of these nests may be read about in a note in his paper, "Ethnological Observations on an American Ant," 1903. He uses Diamond Cement for joining the glass portions of the nests. Should that cement not be easily obtainable, Major's cement is also better than glue. I used for one year a nest stuck together by Major's cement, and then immersed the nest in water for two weeks without loosening the glass parts.

Dr. Wheeler also suggests the use of mica instead of glass in covering the hallways or passages between compartments. I have found celluloid film also better than the glass, and it is tougher than the mica.

It is better to darken the nest by glueing black cloth over the outside walls rather than by painting them, the cloth being more effective and more durable than the paint.

I also find that if a thin pane of orange-colored glass be used for the roofing, instead of the transparent glass, the ants are little disturbed by the lifting of the opaque outside cover, and that their behavior may then be studied with assurance that it is the same as when they were in darkness.

The ideal ant-nests would, I think, be secured were the patterns of the Fielde nests reproduced in white porcelain. Such nests, topped with Turkish towelling, which can easily be renewed when soiled, and with a roofing of orange-colored

the ants were freshly captured from a single wild nest. My first artificial nest was roofed with transparent glass, and is hereinafter referred to as the white nest. The second nest was roofed with double panes of indigo glass, transmitting no light-rays lower in the spectrum than blue. The third nest was roofed with double panes of blue and purple glass, transmitting no light-rays lower than blue, and showing under the spectroscope a very broad band of violet. As the ants in the second and third nests behaved nearly alike, I shall refer to these two nests as the violet nests. The fourth nest was roofed with double panes of orange glass, transmitting only red and green rays, and this nest is referred to as the orange nest. The fifth, the dark nest, had an opaque roofing. All the nests were kept on a table in the diffused daylight that entered a large window, underneath a gas-jet that burned several hours at night. The temperature and the humidity were nearly alike for all the nests, and the same food was supplied to all on the same days. There was never any communication between the nests.

From the beginning, the ants in the white nest and in the violet nests behaved alike in their efforts to seek shelter from the light-rays entering their respective abodes. At first they packed themselves into the hallways, coming out only at night or in very cloudy days for food. The ultra violet rays entering the white and the violet nests, were those that drove the ants to shelter. These rays are invisible to the human eye, and are not shown by the spectroscope; but Forel's ants,[4] *Formica sanguinea* and *Formica subsericea*, withdrew from the isolated ultra-violet rays as from full daylight. For the logic of my experiments the isolation of the ultra-violet rays was not required. There is no doubt that the ants instinctively withdrew from the ultra-violet rays, and that they are indifferent to all the other light-rays. My experiments show that they become fearless of, but not insensible to, these ultra-violet rays, the time required therefor being in direct ratio to the intensity of the illumination from the ultra-violet rays.

It was not until December, 1902, that my ants gave sign of having ceased to fear these rays when in charge of the young. In the night and in cloudy days they brought the inert young out to occupy the sponges in the center of the compartments. Toward the end of January, 1903, the ants in the violet nests occupied the middle areas of their

glass, so tinted as to exclude light-rays above blue in the spectrum, would conduce to the serenity of the ants and facilitate the study of their ways. Cleanliness, the right degree of humidity, pure air and a varied diet presented in minute quantities, enables the ants to live long and prosper in these nests.

[4] "Ueber die Empfindlichkeit der Ameisen für Ultra-violett und Röntgen'sche Stralen," Prof. A. Forel und Prof. H. Dufour, *Zoologischen Jahrbüchern*, 1902.

rooms as serenely as did the ants in the dark nests, with whom they were frequently compared. In the white nest the ants did not bring their young out upon the sponges, in bright daylight, until the end of February.

In the orange nest, on the contrary, the ants behaved from the beginning as did those in the dark nest, never huddling in the hallways nor seeking the shade of the walls. They often clustered in the most highly illuminated portions of the area. All the actions of the ants indicated that they were insensible to the red and green rays.[5]

As the nests were new and nearly alike in structure, temperature and humidity, there seems to have been no reason other than that which lay in the difference in light-rays, for the difference in the behavior of the ants in the different nests, those in the white and the violet nests behaving nearly alike, and those in the orange and the dark nests behaving wholly alike. The point to be here noted is that the ants in the white and the violet nests learned to be unafraid of the rays that at first drove them into corners. After ten months' exposure to these rays they were still sensitive to them, preferred shelter from them, and would soon move to a room of which I changed the roofing to such as covered either the orange or the dark nest; but they appeared to have learned that those light-rays were innocuous. Not only, then, can these ants become acquainted with human beings, lose fear of them and cease to sting them; not only can they become acquainted with ants of alien families and thereupon cease to quarrel with them, but they can become unafraid of certain light-rays and adjust their behavior to conditions to which they were instinctively averse. They are susceptible to education through the eye as well as through the sense of smell.[6]

[5] *Formica subsericea, Cremastogaster lineolata, Lasius umbratus* and *Lasius latipes* behave in the same manner toward these rays.

[6] Something that appears purposeful in the behavior of my ants is their carrying of morsels of hickory-nut or other dry substance and dotting with it the surface of a lump of Turkish paste or other viscid sweet that they like to eat. They then stand with clean feet on the stepping stones that they have laid and lap the sticky food. Oftentimes the sticky sweet is the only one among several kinds of food in their food-room that is flecked by these bits of nut. It may be that ants enaged in carrying morsels of food come upon something more luscious, and drop the former in order to enjoy the latter. They are apt to give special attention to any new dainty.

Dr. Wheeler, on p. 18 of the paper referred to in note 3, says of his *Leptothorax* that "isolation brought out an instinct which is common to all ants known to me except *Polygerus*, ... the instinct that impels them to collect dead sister ants, little particles of earth, etc., and to deposit them on liquid food in the manger." When cleaning up their dwellings, as my ants do, carrying particles to the rubbish-pile, as is their wont, diversion of their attention will often cause them, as it will cause monkeys, to drop the thing they carry. The same or another ant may pick up the dropped particle, if it be not beyond recovery. They hold more tenaciously to the young that they have in charge.

In all five of the nests I watched the rearing of progeny from the deposit of the eggs through the larval and pupal stages to callows. In the violet nests the young were as numerous and as advanced in development at any one period of time as were the young in the orange or the dark nest. It is certain that eggs, larvæ and pupæ may pass their whole career normally and may develop into healthy callows, spending all the daylight hours under rays from which the ant-nurses instinctively withdraw them. The base of the instinct must therefore lie in something other than injury done to the young by these rays.

In the latter part of June, 1903, the ants having been ten months in these nests, I introduced into each of the five nests one queen and five adult workers, all marked, from each of the other four nests. The ants were introduced one by one, and were watched for some minutes thereafter until the manner of the reception of each was ascertained. In no case was there sign of animosity toward an ant that had lived ten months in daylight, in light-rays of another color, or in the dark. After twenty-four hours spent with their ancient comrades. all the marked ants were alive and were taking part in the care of the young. Later, I distributed all the ants in the five nests equally in two other nests and they continued in peaceful association together. These ants had not lost their aversion to aliens, for, when I introduced such, they were soon torn in pieces. *Ten months' residence in the light of day, or under light-rays of different wave-length, does not cause a difference of contact-odors in the adult ants.*[7]

Twenty callows reared in the violet nests from the deposit of the egg upward,[8] were segregated under violet rays in a Petri cell, for two weeks, that they might separately establish their nest-odor, and become engrossed in the care of young. Twenty callows reared in the orange nest from the deposit of the egg upward were likewise segregated under orange glass for two weeks. On the 12th of June I transferred, one by one, about half the ants in each cell to the other cell. All were received amicably and were permitted to share in the care of the young. *The*

[7] The color of the ants was not noticably altered by exposure to any of these rays. All the callows acquired color like those in the dark nest.

[8] Although the fact has no bearing upon the present series of experiments, as all the callows in these nests were presumably the issue of queens, I here note one of the records of the last few months. Four workers, of whom one was major, two minor, one minim, were hatched from pupæ segregated in one of my Petri cells, in August, 1902. They lived always in segregation, never saw a king, and on March 8, 1903, had laid nineteen eggs. Nine days later several of the eggs had hatched and two of the larvæ were well grown. There was no room for doubt that these eggs were parthogenetic, or that they were laid by a worker about six months old.

young ants, like the adults, failed to discern any difference in contact-odor due to diversity in the light rays encountered."

In order to ascertain whether exposure of the inert young to different light-rays would result in different contact-odors at a later time, I took amber pupæ, between April 12 and May 12, from the violet nests, and segregated them in a dark Petri cell, and I likewise segregated in another dark cell as many pupæ from the orange nest. From the violet nests I thus secured about twenty callows, all hatched between April 23 and May 14, that had passed the egg, the larval, and most of of the pupal stage exposed during all daylight hours to the rays at the upper end of the spectrum and without exposure to the red or green rays. From the orange nest I likewise secured about twenty callows, all hatched between April 17 and May 14, that had been exposed during the same period to the rays at the lower end of the spectrum, without exposure to blue, violet or ultra-violet rays. No callow had met an ant of other group than the one in which it was hatched. When the youngest callow was one month old, on June 13, 1903, I introduced several callows, one by one, from each cell into the other cell. All were amicably received and were straightway permitted to share in the care of the inert young; and when I united all the occupants of the two cells they lived together harmoniously. *The exposure of the eggs, the larvæ, or the pupæ to unlike light-rays does not produce unlike contact-odors in the ants developing from the exposed eggs, larvæ or pupæ.*

The results of these experiments shows that *the contact-odor of these ants is not affected by the light-rays from which the ant-nurses instinctively withdraw the young; nor is exposure to light a cause of such change in the contact-odor as is coincident with age.*